A Single-stage Air Compressor

THE MODEL ENGINEER

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Although the inter-club events of the model power boat fraternity are now suspended, the lone hand still carries on. Our picture shows a Scottish reader, Mr. J. A. Laing, about to try out a model speed boat, fitted with an "Atom III" 30 c.c. engine; both hull and power plant are home - constructed.

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Editorial Comments

Thirty Years of Model Making

AT a recent war-time meeting of the Society of Model and Experimental Engineers, Mr. E. W. Hobbs gave a lecture titled as above. Thirty years is a long time, and provides scope for considerable development of one's skill; also, it is a long enough period for noting a great deal of change, not necessarily in workshop methods and processes, but more particularly in the steady growth of the craft of model engineering generally, and the improvement in facilities by means of which model engineers are able to equip their workshops and obtain the materials they require. By means of a large number of lantern-slides, Mr. Hobbs added a great deal of significance to his remarks, and clearly illustrated the progress made during the period under review. As might be expected, steam-driven model boats came in for a great deal of attention; but by no means the least interesting part of the lecture was the section in which Mr. Hobbs showed how his mechanical abilities were turned to very good account by devising all manner of interesting mechanisms for the control of the movements of artificial limbs, for the use of war-maimed heroes during the period 1915 to 1920. After this temporary but important diversion, Mr. Hobbs turned his attention to model work once more; and, in his lecture, he referred to the years that immediately followed the last war as a period in which a rapid growth of interest in model engineering, generally, took place. This was, no doubt, a reaction on the part of those natural craftsmen whose energies had, during the war period, been devoted to more serious occupations. There is reason to believe that a similar reaction will occur after the present war, and that the next thirty years will witness a further development in the aims and attainments of model engineers all over the world. Many are engaged on war-time duties of one sort or another; but, when hostilities cease, the home workshop will come into its own, once again, not only as a healthy and instructive recreation, but also to re-establish that indefinable " spirit " of model engineering that is so essential to our progress.

* * *

Model Engineering Friendships

THE link which THE MODEL ENGINEER forms between friends in all parts of the world is well known, and evidence of this service reaches me constantly. Here is a letter, however, from Mr. E. W. Fraser which illuminates this aspect of our work very clearly, and is, I think, worth publishing. Mr. Fraser is, of course, well known as one of our Championship Cup winners, and a steadfast advocate, not only of good craftsmanship, but of extending a helping hand to beginners in the craft. He writes:—" It was with much regret that I read in your columns of the death of Mr. A. M. H. Solomon. Some years ago, when I was collecting early books on the history of the turning lathe, Mr. Solomon was making frequent journeys to France, and he most kindly got me several rare and old French works on early lathes and appliances, and I still have a letter of his giving some particulars of Plumier and his life. Plumier (1700) wrote the first known work devoted exclusively to turning and the lathe, and I have a copy of his book. Mr. Solomon and I have had many interesting talks at the meetings of the London S.M. & E.E., a Society which owes its existence to THE MODEL ENGINEER, of which I can justly claim to be a ' Constant Reader,' as I have got it from No. 1, and I related in it some years ago how a tiny paragraph published in its pages changed my whole career in life for the better. Many friendships have I made through its pages, and I get letters from South Africa and Canada from model engineers whom I have never seen, but are nevertheless ' absent friends.' Nearer home, I have been friendly with many members of model engineering societies whose names are well known to your regular readers, and I still retain the firm friendship of one of the best, known as ' Uncle Jim.' " Mr. Fraser, whose fine model of a " King George V " loco. has been much admired, tells me that he is yearning to build yet another loco., something of a spectacular type, with " plenty of polished brass about it." I have no doubt that one of the " old timers " will give him suitable inspiration, and, when finished, his new model will be well worth inspection.

Percival Marshall

Model Engineers and National Service

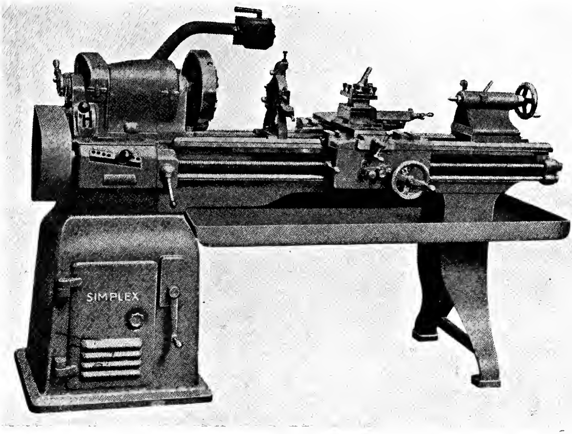
Some notes on modern production lathes

By Edgar T. Westbury

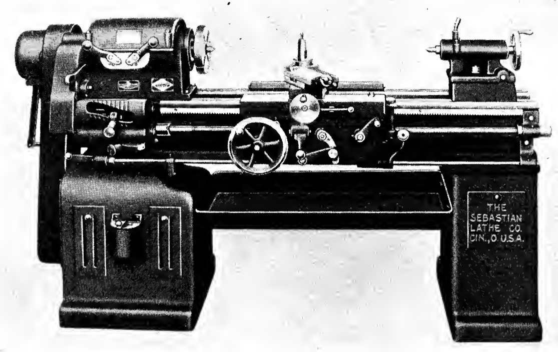
IT has already been noted that the form of lathe with which model engineers are familiar is still far from becoming obsolete, but, on the contrary, is quite in favour for certain kinds of armaments work. Before dealing with the more highly specialised types of machine tools, therefore, it is proposed to give some notes on the more or less orthodox types of lathes most likely to be encountered in modern factories.

Such lathes, commonly defined as " engine " lathes, still conform in their design and equipment to the principles laid down by the pioneers of mechanical engineering, such as Whitworth and Maudslay; that is to say, they are specifically built for metal turning, and have a multi-speed headstock spindle, usually with back-gearing or its equivalent, a sliding tailstock, usually arranged to set over for taper turning, a carriage with slides for supporting and controlling the motion of the cutting tool in two or more directions, and a lead screw with suitable change-speed gearing for cutting threads of various pitches. In this respect they differ very little, if at all, from the model engineer's home workshop lathe; but in the evolution of design, and in conformity with the requirements of workshop practice, many modifications and improvements of their details have been introduced, so that many modern engine lathes show features very dissimilar to their more primitive counterparts.

It is almost inconceivable that any model engineer's horizon has been bounded entirely by the walls of his own workshop, and that he has never seen any lathes except those such as he



The 6½-in. centre Simplex " M " lathe by Soag Machine Tools Limited. This lathe does not possess a geared headstock, but has an enclosed four-step cone pulley driven by internal belt from a countershaft and motor in the pedestal cabinet.



The Sebastian 14-in. swing (7-in. centres) lathe, with fully geared headstock and variable feed gearbox.
(By courtesy of the importers, Messrs. Dowding and Doll Ltd.)

himself employs. He will, in most cases, have had some opportunity of studying the design of modern engine lathes, if only from a handbook or a maker's catalogue. The above remarks may, therefore, appear to be superfluous, since most readers will be aware of the differences referred to. It will, however, be helpful to consider the exact significance of special features of design, and their effect on the operation of the lathe, also its capacity to deal with work, and its scope of utility.

Adaptability

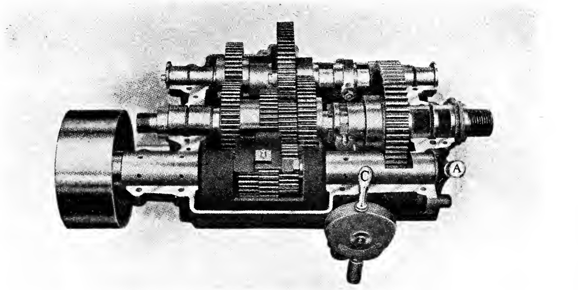
In the latter respect, it may, perhaps, be considered that the general scope of lathes has tended to become narrower rather than wider; but this is only true if one regards a lathe as a purely universal machine tool, as, indeed, the average model engineer is often obliged to regard it. Thus the modern engine lathe is not intended to be adaptable to such operations as milling, drilling, grinding, etc., and, in many cases, no provision is made for saddle boring either, as such operations can be much more efficiently done by separate machines specially designed for the purpose. This may be regarded as the fundamental difference between the model engineer's lathe and the engine lathe, since the adaptability of the former to work which is really outside the sphere of turning operations must always be an important consideration in design.

On the other hand, the scope of lathes, within what may be termed their legitimate sphere of operations, has been increased in recent years by the provision of wider ranges of spindle speeds, and automatic sliding and surfacing feeds, while most lathes are equipped for cutting a wide range of English and Metric threads. Collet chucks are usually provided, either as standard equipment or extras, and taper and form turning attachments, also various types of steadies, etc., are available. In many cases, an engine lathe can be adapted for repetition work by the addition of multi-way toolholders, etc., in which form it constitutes a kind of transitional machine, capable of dealing with much of the work which would normally be undertaken by much more elaborately-tooled capstan or turret lathes. It is in this form that it is, perhaps, most likely to be encountered by model engineers starting work in an armaments factory.

Work Capacity

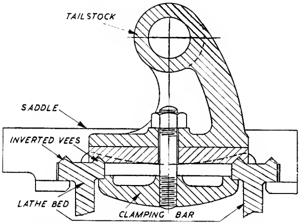
The term " capacity " in this case does not refer to the matter of dimensions, which are, of course, always exactly defined for any particular lathe; but to the rate at which a lathe is capable of handling the work it is called upon to perform. This has in nearly every case increased very considerably in recent years, and in fact much of the advance in lathe design has been a slow evolution of the design of structures, bearing surfaces, slides, etc., to cope with the ever-increasing demands which industry has made, in the effort to turn out work faster and still faster.

One of the most obviously noticeable features of almost any modern lathe, therefore, is its massive-



The interior of a modern multi-speed all-geared lathe headstock.

ness and rigidity as compared with the older types; but this is by no means the only way in which they have been improved in the direction of increased working rate. The finer details of design have been improved with equally important effect, and good use is made of improved constructional materials. As lathes have had to deal with harder and tougher steels, the necessity of making their own working parts of similarly more tenacious metals has been a logical conclusion.



Cross section through the bed and tailstock of a modern lathe, showing the application of separate vee-ways to carry the tailstock and saddle.

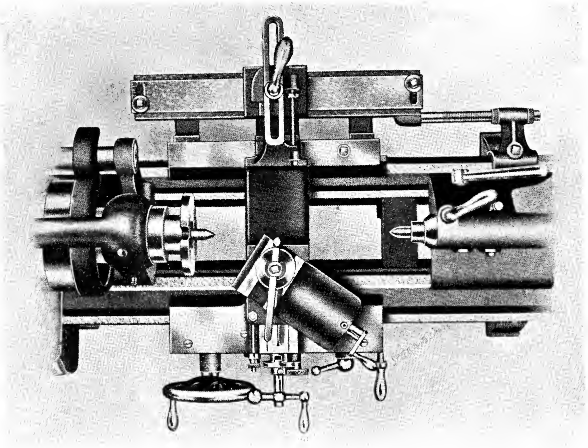
Generally speaking, the maximum and minimum speeds of lathes of a given size remain much the same as they were about twenty years ago, but the range of speeds has increased in many cases, and they are better adapted for really hard work at the higher rates of speed than they used to be. The top speeds, on the older lathes, were only suitable for quite light work, and continuous or too prolonged use of them would mean rapid deterioration of headstock bearings and other highly stressed working parts.

All-Geared Headstocks

While many modern lathes still retain the old familiar multi-step headstock pulley, there is a steadily increasing tendency to drive the spindle through a change-speed gearbox, from a single drive pulley running at constant speed. This system has obvious advantages, enabling the maximum possible torque to be applied to the spindle with the minimum side thrust, and also being much simpler to operate, avoiding the need to manipulate perversely obstinate belting when changing speed. In the case of the Colchester "Triumph" lathe illustrated, the gearbox provides eight speeds, from 30 to 340 r.p.m. The gears are operated by three selector levers, with an interlocking device which makes it impossible to engage two gears simultaneously. For stopping and starting the lathe, either a friction clutch or fast-and-loose pulleys may be employed. The enclosure and lubrication of the gearing are arranged by making the headstock casting in the form of a box, which is kept filled with oil to a predetermined level; the rotation of the gears distributes the oil to all sliding surfaces and bearings, including those of the main spindle. In most cases the top of the gearbox is closed by an inspection plate.

Mandrel Design

It is obvious that as the cutting rate of lathes of a given dimensional capacity is increased, more power must be transmitted to the mandrel, and for this reason alone, modern lathes must have much larger diameter mandrels, and mandrel bearings, than formerly. This feature also contributes to their rigidity under heavy cuts, and



Plan view of the saddle of a Hendey lathe, with taper turning attachment at rear.

enables them to run for long periods under load at high speeds. Another reason for increasing the mandrel diameter is to allow of boring it to take increased sizes of bar work through the centre, and to allow of fitting collets or automatic chucks.

The mandrel bearings of modern engine lathes are, in most cases, plain bushes of bronze or other special bearing metal, sometimes of the split "plummer block" type, and in other cases of the split conical adjusting type. Single or opposed cone mandrels do not appear to be very extensively employed in modern engine lathes, probably because of the difficulty in fitting and maintaining them in a sufficiently accurate condition to realise their special advantages.

Ball and roller bearings have been successfully employed in several modern lathes, but for very many reasons have as yet failed to become really popular. The best form of bearing in this class, for the purpose, appears to be the tapered roller bearing, especially in view of its capacity for withstanding heavy end thrust, or combined thrust and radial loads. Such bearings are generally arranged in opposed pairs, pre-loaded in an endwise direction to take up the least trace of clearance. Roller- or, more often, ball-races, are, of course, extensively used, in conjunction with plain bearings, for dealing with end thrust.

Little may be said about the design of the tailstocks of these lathes, as they differ only very slightly from those of the older lathes, and such modification as they have undergone is mostly towards increased stiffness and rigidity, in proportion to the other essential components. Provision for set-over is general, and in most cases the method of fitting the tailstock to the bed provides for it to be guided by separate ways or surfaces to those which carry the sliding saddle, so that wear on one set of ways will not affect the fit or alignment of the other.

The usual way of effecting this end is to provide the lathe bed with two pairs of inverted vees, the outer pair being used to guide the saddle and the inner pair to guide the tailstock. Another very important reason for the prevalent use of inverted vees in modern lathe practice is that, in cases where the load is mainly downwards, wear is evenly distributed on the two symmetrical sides of the vees, and thus alignment is not affected.

[The photographs of lathe components are reproduced from Vol. I of "Machine Tools," by kind permission of the Gresham Publishing Co., Ltd. Acknowledgments are also made to the makers and importers of lathes referred to, who have furnished the other photographs.]

(To be continued)

Horizontal Drilling and Milling Spindle

A self-powered device for the lathe which can be easily made. It will find many uses in the workshop

By Ernest F. Carter

THOSE who are building model petrol or steam engines will find a ready use for this simply-made little attachment for their lathes. It is a horizontal milling and drilling spindle, powered from a fractional horse-power motor mounted upon the same bed.

The sketch shows the general idea, and it should be possible to build the attachment up from odd scrap materials. It consists of a short spindle, carrying a drill-chuck, which runs in tapered bearings (for thrust take-up) and packed up to lathe centre; and mounted at one end of a stout piece of mild steel, at the other end of which is fixed the motor.

The whole plate is mounted upon the compound slide-rest on top of the tool-post; and can thus be traversed in the same way as a normal tool.

The drill-chuck can carry either drills, end-mills, reamers or grinding wheels, as desired; while the writer has frequently used burrs therein with great advantage for finishing off parts of crankcases and similarly awkward parts.

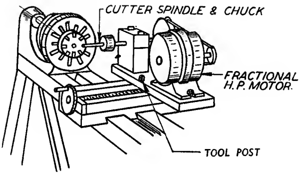


FIG. 1.

General view of spindle

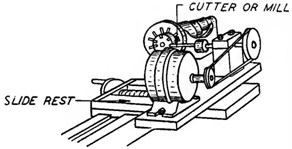


FIG. 1a.

View from rear.

In the unit as made up, the drill-head and motor were both spaced up and held by shaping out blocks of seasoned oak; but there is, of course, no objection to packing with metal if desired.

One of the outstanding advantages of the gadget is that after turning work has been executed in the normal manner, the tool can be removed from the rest and the drill-head substituted, after which all spacing milling and drilling can be done with one setting.

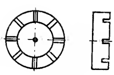


FIG 2

The type of work done.

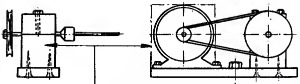


FIG. 3.

General construction arrangement.

Gauges and Gauging

A series of great value to engineers of all classes, particularly those who are engaged upon National service

By R. Barnard Way

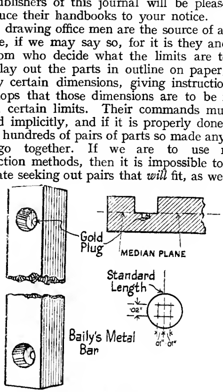
THERE can be no innovation in workshop practice that has brought about a greater change in methods of working than that of interchangeability. First devised by a French mechanic, Le Blanc, making rifles in 1785, it was adopted by Whitney in the U.S.A. on a really considerable scale in 1798. He also was engaged in firearms manufacture. Most of us, no doubt, have some idea that the motor car saw its general adoption; though this was not the case, there is certainly some reason to believe that men such as Henry Ford had a great deal to do with its general introduction into everyday workshop principles. The mention of Ford's name is not intended to decry those of other makers, but the writer had a good deal of experience, in those early days, of fitting " spare parts " into motors. A fitter *was* a fitter then, and there were very few motor manufacturers who could be depended upon to supply spares that would instantly drop into place. Ford was one of these, and it was because he set out to manufacture cars in enormous numbers that he was compelled to make the various parts to a high degree of accuracy, so that the complete assembly would go together with the minimum degree of trouble. Fitting was no part of the assembly of those cars, either in the original putting together or the replacement of damaged parts.

This desirable state of affairs was brought about by deciding first of all the exact sizes to which individual parts were to be finished, and then using every possible endeavour to make them conform to those dimensions.

This sounds reasonably easy, but it needs a very considerable organisation indeed to carry out as a principle. So desirable is it, however, that we now find interchangeability established in almost every sort of workshop, with varying degrees of accuracy according to the article manufactured. Right here we are brought face to face with the decision to make—what is the minimum degree that is necessary? It will be part of the purpose of these articles to help in the making of that decision, because we can show what the responsibilities will be in respect of each extra decimal point. It is the custom nowadays to make light of " thou's " without fully realising exactly what they are. As to that, we shall see presently.

Before going any further, it is as well to remind the reader that a good working knowledge of decimals is absolutely indispensable in the study of limit gauging. Many men, even to-day, get on very well without understanding the system, but there is no way out of it here. To those who are without that necessary knowledge, we would most strongly recommend the acquiring of it; we have no room for instruction in the subject here, but the publishers of this journal will be pleased to introduce their handbooks to your notice.

The drawing office men are the source of all the trouble, if we may say so, for it is they and the toolroom who decide what the limits are to be. They lay out the parts in outline on paper, and specify certain dimensions, giving instructions to the shops that those dimensions are to be made within certain limits. Their commands must be obeyed implicitly, and if it is properly done then out of hundreds of pairs of parts so made any pair will go together. If we are to use mass-production methods, then it is impossible to contemplate seeking out pairs that *will* fit, as we once



Details of the British standard yard bar.

had to do. That would be all well enough if we were not going to undertake the supply of spare parts, though even so it is wasted effort.

First of all, we must establish some standard of accuracy to which everything will conform, and to which final reference can always be made. It is of no use talking about the one hundred-thousandth part of an inch—as we shall presently—unless our inch is the same as everyone else's. Moreover, our inch, in such a case, must conform to the standard inch to the one millionth part, and we can say at once that such a standard will not be easy to achieve. What is the standard to which final reference is made?

We have travelled a long way since the statute of Edward II in 1324, wherein it was laid down that one inch was to be equal to three round and dry barley-corns laid end to end. Experience showed them that barley-corns grew to a size that was almost invariably the same, so that any three could be drawn from a sack with certainty that the

average combination would work out right enough. That is the origin of the English inch, and seeing how deep-rooted that origin is in the soil, it is no wonder that we have clung so stubbornly to it, in face of the more convenient metric system with its basis on some astronomical fact.

In Great Britain, the unit of length is the foot, the origin of which seems fairly obvious, though at what time it first appeared would be hard to decide. No matter, it is the standard, and three of them make the yard, equal to an approximate full marching pace. A standard is of no use unless there is a final reference, and this was realised very early in our history, for the first recorded standard yard was made by order of Edward I. The earliest known is that of 1496, made to the order of Henry VII, and later, that of Queen Elizabeth in 1588. Both of these were brass bars, the first of octagonal and the second of rectangular section, and are preserved at the Board of Trade offices in London.

Queen Victoria's standard bar was of brass, 39.73 inches long, with two gold plugs inserted, and a dot on each of these was separated by 36 inches, or as nearly as possible. How was this separation established? That, of course, is the main difficulty, and remains so to this day. Formerly, it was based upon the length of the seconds pendulum, which varies according to the latitude. Its length in London is 39.1393 inches, and the standard was established by stating that $\frac{39.1393}{36}$ yards would give a correctly oscillating seconds pendulum. The difficulty is to decide what is the true length of a pendulum, as many amateur clockmakers will have discovered. At all events, the replacement of the standard bar was, according to Act of Parliament, to be governed by this very valuable physical fact.

Natural phenomena immediately get to work on our standard bars and make light of their accuracy, if we do not take the necessary precautions. These precautions did not matter a great deal in days before hundredths of an inch were considered of importance. The brass bar responds to change of temperature to the extent of lengthening it a matter of 0.0108 inches, as between the temperature at midnight and midday for instance—taking a range of only 30 degrees Fahrenheit. This was soon realised, and the standard bars were kept in places where the temperature remains as nearly constant as possible. Measurements, or references to them, were made only when their temperatures corresponded exactly with those when the end lines were engraved. This temperature now is always taken to be 62 degrees Fahrenheit.

The present standard references date back as far as 1845. There are five of them, and they are made, not of brass, but of an alloy known as Baily's Metal, actually a bronze with a very low coefficient of expansion. Clearly, any such material is of great value in the making of standard length bars. They were finished by the firm of Troughton & Simms, at a temperature of 62 degrees. Each one is engraved with the temperature at which the length between the reference lines is precisely 36 inches. Here are the details of each one, together with information as to where it is to be found, though, of course, you must not expect to be permitted to see it there at any time:—

No. 1 is 36 in. long at exactly 62°F. (Board of Trade).

No. 2 is 36 in. + 21 millionths at 61.94°F. (Royal Mint).

No. 3 is 36 in. − 33 millionths at 62.10°F. (Royal Society).

No. 4 is 36 in. + 7 millionths at 61.98°F. (House of Commons).

No. 5 is 36 in. − 55 millionths at 62.16°F. (Royal Observatory).

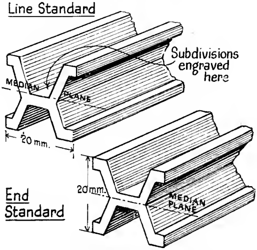
Every precaution is taken with each one of these bars to maintain its condition, and each one is duly tested from time to time. This testing is no easy matter, for though the bars are designed to give the maximum degree of accuracy, there is always the natural factor to deal with. Seasoning of metal may take years, and there are influences at work for the whole life of any such bar that may affect its length. When reference is made to it, the question of its support is important; it cannot be supported merely at each end, for the sag due to its weight is going to shorten it. To reduce this sag effect, the engraved lines are on gold plugs sunk in holes at the depth of the neutral axis; that is, the axis of the bar that neither lengthens nor shortens when the bar is bent. It was formerly floated in a pool of mercury, but is now supported in a special way that will be gone into later.

The actual engraved lines are on gold plugs at the bottoms of two holes drilled in the bar. But every line, be it engraved never so finely, has a width, in spite of old Euclid, who desired it to be agreed that points had position but no magnitude, and lines length but no breadth. The lines engraved upon our British bars do not fall within the Euclidian category, for they have a width, quite measurable, and that a matter of 0.0004 inches. There are three governing lengths, separated by 0.01 inch from each other, the middle ones being the exact yard length indicators. The central intersection is enclosed by two additional lines, parallel, and separated by 0.02 inch. A microscope is required to make reading of the lines possible.

The Metric Standard is not so important to the British workshop man, of course, but it is used to a considerable extent and was legalised by Act of Parliament in 1864, so a few notes upon the subject should be included here. The establishment of this unit of measurement, in 1801, was somewhat optimistic in a sense; it would seem that the British yard, or else the seconds pendulum was in the mind of its inventors. They made

their unit the one ten-millionth part of a quadrant of the earth, measured between the poles, and though this polar diameter of the earth is known with considerable exactitude now, the figure then employed differed from the true one by a good deal. Here are some details.

The metre, as established, is equal to 39.370113 inches, which corresponds to a polar diameter of 7,915.100 miles. The true figure is now accepted as 7,899.166 miles, which gives the proper inch equivalent to one metre as 39.3085.



Sections of modern standard bars.

Thus we see that the choice of some unchanging physical feature of the universe is not bound to be a satisfactory one. Later on, we shall find that the wavelengths of various coloured lights are being employed as final arbiters, and here we really have something more positive to work upon.

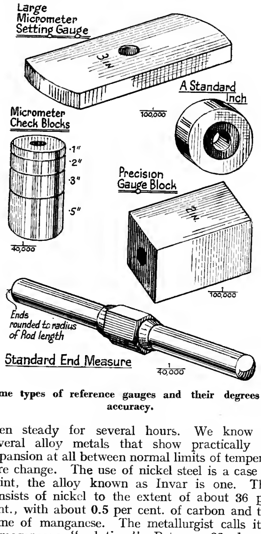
Realising that an error had been made, the French Government amended their statute to the effect that the length of a bar of platinum-iridium, kept at the Bureau of Weights and Measures, Pavillon de Breteuil, Sèvres, Paris, was one metre at a temperature of zero Centigrade. It is known as the Metre of the Archives. This new bar was made in 1872, it is 25 millimetres by 4 millimetres in section, and is an End Measuring Standard, not now regarded as the most satisfactory system. Line standards are preferred, chiefly because to gauge from end standards the measuring anvils have to be brought into absolute contact. As this entails a certain amount of pressure—which would certainly tend to buckle a bar of such a thin section—accurate reference is almost impossible. Where the length is engraved upon a surface, no contact with it is required, the references are made optically; so, in consequence, this is the type now adopted.

These final standards are not sub-divided, they give the whole length and nothing else. Secondary line standards are engraved intermediately, and the usual form of these is shown in section here; as can be immediately observed, the section is H-shaped, the graduations being at the bottom of the trough.

The bottom of this trough, with a line standard, is in the middle of the section, and on it sub-divisions are engraved with a diamond point, the motion of which is controlled by a screw and ratchet wheel. The making of the screw is a job of work unmatched for skill anywhere. The yard standard is sub-divided into inches and twentieths of an inch, and the metre into centimetres and millimetres.

End standards are made in the form shown, here the cross-member is centrally disposed. Both types may be considered as made from a 20 millimetre square bar, though they are not so made.

The man with some knowledge of metallurgy, however little, will at once want to know what materials can be employed for the manufacture of these standards. The expansion due to heat is well understood, and can be allowed for in the way we have already indicated, namely, reading the gauge marks only at certain fixed temperatures, and that only after the temperature has



Some types of reference gauges and their degrees of accuracy.

been steady for several hours. We know of several alloy metals that show practically no expansion at all between normal limits of temperature change. The use of nickel steel is a case in point, the alloy known as Invar is one. This consists of nickel to the extent of about 36 per cent., with about 0.5 per cent. of carbon and the same of manganese. The metallurgist calls it a homogeneous "solution." Between 32 degrees and 105 degrees Fahrenheit the degree of expansion is in the order of one millionth part per degree.

The metal has excellent mechanical properties, and will take a high polish, so that fine lines can be engraved upon its surface. But, and this is a large " but," it tends to grow with age, not much, but enough to make regular checking of the indications very essential. With all accurate devices of any sort, errors do not matter so long as they are known, they can be allowed for.

The search for materials goes on, and latterly the use of fused quartz has been introduced, with platinum plates at the ends for the engraved lines. The quartz bars are carefully annealed, first by heating at a temperature of 840 degrees Fahrenheit for eight days, and then carrying out cooling over a period of at least fourteen days. In this way a material is obtained free of any sort of internal stresses, which can be relied upon to keep faithful record.

Faithful record? Yes, but for how long? A century is not enough, nor a thousand years, for a permanent record. There are few things that will not change in the first period, never mind the second, but there is one which is eternal, the wavelengths of the vibrations in the ether that produce light of different colours. If we burn some salt of sodium, the yellow light produced has a wavelength of 0.0005893 millimetres; it has always had it and it always will. Burning a cadmium salt and observing its spectrum we see that there are prominent indications of red, green and blue, and that these always occur at exactly the same points. Measurement, by methods that we cannot go into here, show that the wavelengths of two of these indications are:—Red, 0.00003 in.; blue, 0.000018 in. Measured in metres, the figures given are:—

1,553,163.5 wavelengths of red to the metre.
1,966,249.7 wavelengths of green to the metre.
2,083,372.1 wavelengths of blue to the metre.

For us, in these pages, such matters are not really of practical importance, they are given to show what the establishment of a final standard really means. The same thing, on a limited scale, must be faced by the workshop men who decide to introduce a full system of gauging into their shops. Every gauge employed must be checked by another gauge, and this second one must be accurate to at least one more decimal place. Further than this they must go, for there must be a check on the checking gauge, and even then, another.

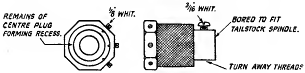
Suppose that the workshop gauges are accurate only to 1/100 in., 0.01, then the test gauges must be accurate to 0.001. To test these, our check gauge must be accurate to 0.0001, and the final standard to 0.00001. Such a set of equipment has to be treated with great care; the items are made in quite a variety of forms, some of which are here illustrated. The actual shop gauges are special products of the tool-room, designed for the articles to be gauged, so there might be an infinite number of varieties in form and size. These will be the subject of study in subsequent articles.

(To be continued)

Lathe Die-Holder Suitable for the "Adept" Super

By C. F. Hallett

THE device described below should be found useful to " Adept " lathe users, and is quite easy to make. I have found it efficient, although, perhaps, the scope is somewhat limited in its present form. Readers, and beginners like myself, who find it trying to start a thread



correctly will find this little device help them over their difficulty in many instances, especially on small turned work.

First take out centre plug of an old sparking plug and remove electrode, screw plug back in tight, and then cut off flush with end of plug body. Set up in four-jaw (holding by screwed end that fits in cylinder), to run true by surface gauge on bed, or slide, setting pointer at joint of threads of outer body and centre plug. Bore out 13/16", dia. of die, and 3/16" deep, face bottom. The centre plug now forms recess for die. Now set up long boring tool, and open out back end of body to a nice fit for tailstock spindle. Remove from chuck and reverse, holding by hexagon part of plug, set to run true, and turn off screwed part, also face end. Now take out of chuck, and on each of three adjacent flats of hexagon part mark off, centre-pop, drill, and tap 1/8" Whit., to take adjusting screws. Another hole, tapped 3/16" Whit., is drilled in the end that fits tailstock to take a grub-screw. This screw fits into slot of tailstock spindle and prevents die-holder turning round when in use.

The centre plug, as stated, forms recess for die to rest against; without this, die would lie too far in body of plug. It is important that the job is set to run as true as possible, by inner threads of body in the first stage, as, after machining away the threads, a mere skim is all that is wanted to open out to 13/16".

The holder allows about $1\frac{1}{4}$" of thread to be run on stock in chuck, but the back end could be bored out larger and a sleeve made any length to fit tailstock. The best method in use is to slide tailstock along bed by hand, turning chuck or belt at same time.

* Small Centrifugal Pumps

Further practical hints on their design, construction, and application

By "Artificer"

THE employment of direct-driven pumps such as these illustrated is to be preferred to the use of belt or even geared drives, as these are less mechanically efficient, and may introduce an element of unreliability.

It may be noted that in at least one case a centrifugal pump has been successfully employed as a fuel pump for a model boat, a rather remarkable achievement, in view of the fact that absolutely positive delivery of a very minute quantity of fuel is the essential requirement in this case. The pump referred to was fitted early this year to Mons. Suzor's famous *Nickie V*, and functioned quite well until the career of this boat was terminated by an unfortunate mishap.

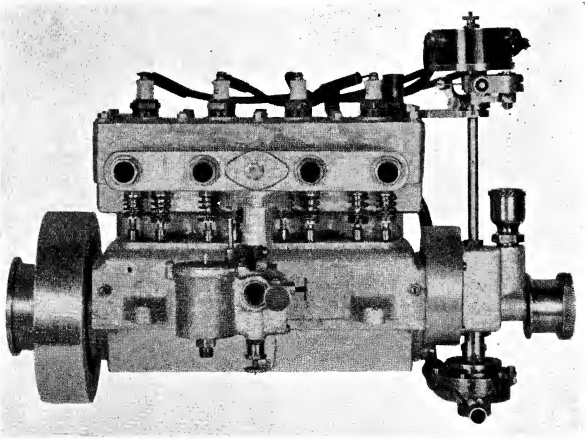
Small multi-stage centrifugal pumps have been employed in full-sized practice to boiler feeding, and suggestions have been made for emulating this development in model steam plant. While it would not be impossible to construct a very tiny pump of this type, it would not be an easy matter, in view of the complex passages and microscopic clearances necessary; there are also several other practical difficulties which make such a pump less attractive in practice than a simple geared ram pump.

A centrifugal pump could, however, be very effectively employed in the feed system of a model steam plant, as a "service" pump to ensure that the suction side of the main feed pump is always plentifully supplied and free of air locks. As is well known, feed pumps often fail from starvation on the suction side, and such faults might easily be prevented in this way.

A Medium-sized "General Service" Pump

This pump, illustrated in Fig. 9, was designed by the writer some time ago, to fill the need for a somewhat larger pump than those commonly available for small garden fountains. It has a low-pressure output of over 500 gallons per hour, and will deliver, at a lower rate of output, to a

* *Concluded from page* 507, "*M.E.*," *November* 2, 1939.



The "Wall" four-cylinder engine, showing circulating pump.

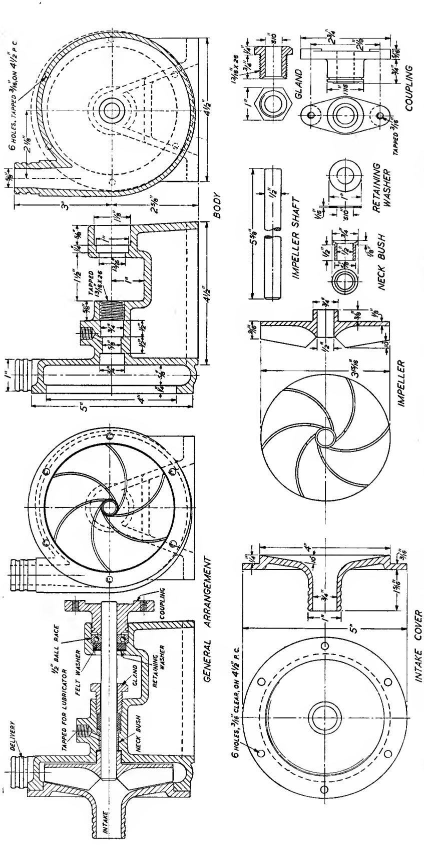
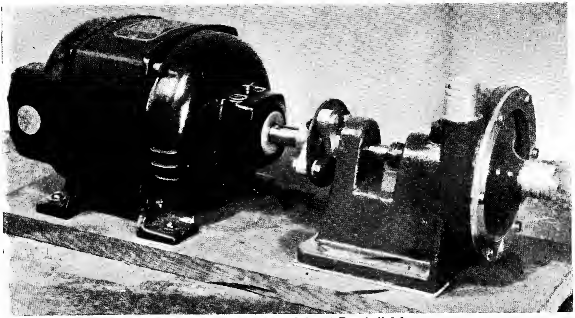


Fig. 9. General arrangement and details of a simple pump suitable for amateur construction, having an output of 500 gallons per hour.

height of 25 ft., at a rotor speed of 2,800 r.p.m. (These figures do not represent ultimate capabilities, but have been measured under ordinary working conditions.) Such a pump has a very wide range of practical utility, and in conjunction with a $\frac{1}{4}$ h.p. motor or a small petrol engine, forms a very useful portable fire engine or salvage pump.

The special features of this particular pump are its simple mechanical design (from the point of view of easy machining, with simple equipment) and the provision for long wearing life with practically no attention. It is thus highly suited for duties where absolute reliability under conditions of arduous duty is essential. The pump body may be cast in iron, gunmetal, or corrosion-resisting aluminium alloy, and embodies a rigid box bedplate incorporating a housing for an "outboard" bearing at the coupling (or belt pulley) end of the shaft. This bearing may be either a plain bush or a ball race, the latter being recommended, but in any case the housing must be bored out to a sufficiently large diameter to admit a tap for cutting the internal thread of the gland. In order to ensure the minimum wear of the inner or "wet bearing" a selected material is employed for the bush, such as graphite-impregnated bronze, or laminated fabric bakelite, neither of which require oiling; but a gunmetal bush is quite satisfactory, provided that a grease lubricator is fitted—and *used*! Soft packing has been found to give good results and no renewals or even adjustment is necessary for long periods. The gland is fitted with 0.005″ clearance all round the shaft to eliminate the possibility of



The pump shown in Fig. 9 coupled to "Batwin" $\frac{1}{4}$-h.p. motor.

binding if its thread should not be perfectly true.

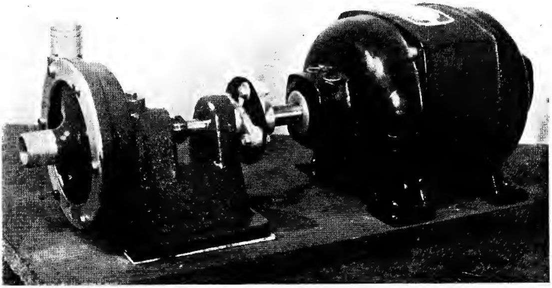
In order to prevent water creeping along the shaft and reaching the ball-race, the latter is protected by a thick grease-impregnated felt washer, retained under compression by a metal washer, and the boss of the coupling, which forms a spigot entering the open side of the housing, is grooved so as to provide a labyrinth seal. These measures have so far proved effective in protecting the ball-race from corrosion.

Both the rotor and the coupling are pinned to the stainless steel shaft, after the end location of the impeller has been adjusted to clear the end cover by about 0.005", by means of a bakelite washer of the required thickness at the back of the impeller boss.

To couple the pump to the driving motor, a flanged member similar to that shown is fitted to the motor shaft, and a leather or fabric disc interposed, as shown in the photos. Any other standard form of coupling, however, including belt drive is, of course, permissible.

Essential Conditions in Pump Design

It is well known that no centrifugal pump will start working against an appreciable suction head, due to the fact that it cannot produce the normal difference of pressure between the suction and



Another view of 500 g.p.h. pump and motor.

delivery sides until the casing is filled with the working fluid. It is thus essential to install pumps, whenever possible, so that the intake is below the level of the water from which their supply is taken; when such conditions are not practicable, provision must be made for "priming" the pump when starting. This may consist of an exhausting device such as a steam, air, or hydraulic ejector in the discharge pipe, or a water service into the intake.

By fitting a non-return valve to the suction pipe, water may be retained while the pump is standing, so that subsequent priming is unnecessary; but this pre-supposes that the valve will remain hermetically tight for an indefinite period—a condition which is not always easy to guarantee in practice.

The inherent characteristics of the centrifugal pump provide in themselves a perfectly adequate and logical reason for the necessity of ensuring an unrestricted and uninterrupted flow into the intake of such pumps; this requirement is perhaps the most vital of all, and applies not only to the design of the pump itself, but also to the arrangement of its service piping. Should the intake to the pump in any circumstances become partially or completely throttled, the impeller vanes are liable to cavitate, just as propeller blades will under somewhat similar conditions, and thus the discharge from the pump will be either intermittently or completely stopped. Very much the same effect will take place if air is allowed to leak into the suction system; quite a small air leak will put a large pump out of action, especially if it is called upon to deal with a fair suction head.

The next most important essential in pump design, for reliable operation, is the avoidance of excessive rotor clearances, or other possible leakage paths from the discharge back to the intake. Where this fault is present, the symptoms may be either a serious lowering of the output volume or pressure, or a tendency to surge badly. This is often noted in the case of pumps which have become excoriated internally, as a result of handling impure fluids.

When the conditions stated above have been complied with, there is little doubt about the capabilities of any pump to perform reliably; but questions of maximum output and pressure, especially when related to expenditure of power, depend upon finer points of design, and when they are of great importance it is necessary to investigate theory to a much deeper extent than is done in this article, which makes no pretence at being a scientific treatise.

Getting That "Glass Case" Finish

A "collectanea" of proven recipes for the colouring and surface preservation of metals

ENGINEERING models can be divided rather arbitrarily into two classes, those which are designed actually to operate under precisely similar conditions to those prevailing with the full-sized original, and those which are built as more or less "show-case" models, capable of being driven by some separate source of power to simulate the movements of the prototype.

These notes on metal finishing and protection are addressed primarily to those building the latter class, who realise that, however well-finished a model may be, there is always the dreaded rust demon ready to take away that pristine brilliance so much sought after by all model engineers.

Many readers who have spent happy hours in the Science Museum at South Kensington must at some time or other have speculated with a heartache upon the methods used to get that marvellous finish *and keep it!* That perfectly blued steel, that superb matt white and dead black that will not rub off! How they are envied. So here are some tried recipes with which these results can be obtained, the only stipulation being that the reader would do well to bear in mind that as some of the methods used employ dangerously poisonous chemicals he must exercise due care and not handle the items being treated until they have been washed.

Blueing Iron and Steel

A true professional blued steel finish can be produced by making up a saturated solution of copper sulphate, and in another receptacle a strong solution of common photographic "hypo" (hyposulphite of soda) into which a drop or two of hydrochloric acid ("spirits of salts") has been added.

The item to be blued should first be well cleaned with "blue-back," and handled only with forceps after cleaning to ensure freedom from grease and perspiration. It should then be dipped into the copper sulphate solution and allowed to remain there according to the depth of colour required. It should then be lifted out, washed in hot water, and immersed in the "hypo" bath for about ten minutes, when the blued finish will be apparent. A further wash in hot water, followed by a dry-off, a polish, and a coating of cold lacquer; and—there is the finish.

Whitening Brass

The methods of whitening brass are multitudinous, but here is a recipe—that of dull silver-plating—which gives an unimpeachable finish, provided that the actual surface of the brass has been got up to a high degree *before* treatment; as neither with this recipe nor any of the others

following can a perfectly smooth finish be expected unless the underlying surface is unblemished.

Proceed first to make up the plating bath as follows:—Dissolve ⅛ oz. of silver in nitric acid, using the "B.P." and not the "commercial" variety, which latter is too impure. After solution is complete, add about half a pint of water to it, and precipitate the silver chloride by pouring in a strong solution of common household salt. Next, decant off the liquid from the white mass of "curds" which have sunk to the bottom, throwing the liquid away and adding to the "curds" an equal quantity of "cream of tartar" (bitartrate of potash). Finally add enough water to make the mixture of the consistency of cream. This is the plating bath.

After thoroughly cleansing the part to be whitened, move it about in the solution—holding it with forceps—till upon removal and inspection it is seen to be coated all over. Remove from the vat, wash well in hot water and dry off in a sawdust bath. A coat of cold transparent lacquer will prevent the silvered surface discolouring purple if exposed to certain bad atmospheres.

Blackening Brass

To obtain that metallic black finish so much desired, here is a formula which is known to be eminently satisfactory and easy to use.

Make up a solution consisting of ½ oz. of lead nitrate and ½ oz. of "hypo," both crystals being dissolved in half a pint of hot water.

The component to be blackened should first be scrupulously cleaned, washed, and finally dipped in the mixture while the latter is hot. Sulphate of lead is actually deposited upon the surface of the article, which first turns bright yellow, then blue, and finally black.

When the desired depth of colour is obtained, remove from the vat and dry off; finally lacquering immediately, otherwise fading will occur.

Whitening Cast-Iron

The wheels of exhibition glass-case models may be whitened quite easily by immersing in a solution made up by mixing an equal quantity (by bulk, not weight) of mercury and ammonium chloride; finally dissolving the mixture in cold water.

The article to be whitened should first be heated to dull redness and immersed in the liquid. It will come out having a dull silver-white finish, which must be protected by washing and lacquering as before.

A Rust Preventative

Those who believe in the maxim, "Prevention is better than cure," may be interested in the following dodge.

Steel tools and parts smeared with a preparation made up by heating together six parts of lard and one part of resin—and allowed to cool—will not rust readily owing to the fact that the coating provided is a moisture-resisting one.

Brass Coating "Die-Casting Alloy"

For exhibition work only—the writer trusts—pressure die-casting alloy (zinc alloy) components may be brassed over to be indistinguishable from that metal by immersing them in the following plating bath, and subjecting them to a steady direct current of from three to four volts.

The solution, which contains the intensely poisonous copper cyanide, is proportioned thus:—Copper cyanide, 1½ oz.; metallic zinc, ⅜ oz.; soda ash, 1/6 oz.; ammonium chloride, 1/6 oz.; water (distilled), ½ gallon.

Now, as to the electrical side of the business. Procure a small glass or stone jar to form the plating vat. This must be well washed out with boiling soda water and rinsed with hot water before the solution is poured in. Next, lay two short pieces of wood across the mouth of the jar from which to hang the article being plated and the other pole, which should consist of a piece of copper about the same size as the article being plated.

The wire connected to the article should be connected to the negative pole of a 4-volt accumulator or dry battery of large capacity, and the wire joined to the copper plate must be taken to the positive pole on the battery or accumulator.

During the plating operation, the article and the anode—as the block of copper is called—should never touch each other. And it is well to remember that, if a really thick deposit is required, it is best to plate for half an hour, then remove from the vat, thoroughly clean the article, and re-immerse for another half an hour.

Cleanliness

A word as to the preparation of the item for the plating vat. Although cleanliness is an essential feature for any form of metal deposition, electro-plating demands absolute mechanical *and* chemical immunity from all forms of grease and oil; and to this end, here is a system of cleaning components for any of the previously cited recipes, or for the one under consideration.

Dissolve half a pound of caustic potash in a gallon of water, and into this solution place the article (after having already cleaned it up with the scratch-brush), hanging it from a piece of wire. Next remove it—still on the wire—and rinse it in boiling water, after which it may be introduced into the plating vat.

After the metal deposit is complete, the job should again be washed in hot water, dried, and polished with any good silver or brass polish, and finally lacquered to the desired "brassy" tone required, according to taste.

By substituting a saturated solution of copper chloride in the vat, and proceeding along precisely the same lines, items such as "copper-top" locomotive funnels may be copper-plated, instead being turned up in solid copper, which anyone who has tried it will agree is no easy task, particularly in the smaller scales!

A Single-Stage Air Compressor

Some suggestions for making a small power-driven machine

By Bertram C. Joy

THOSE people who are interested in the making and operation of small stationary prime-movers—and particularly the steam engine—are generally on the look out for small machines which can be conveniently driven by such engines. If some practical purpose can be achieved, so much the better, but this is not always of much importance. I think that the small air compressor about to be described may be considered to have a few useful applications in the amateur workshop. For example, compressed air " on tap " may be usefully employed in connection with a small blowpipe, for soldering and other local heating purposes; an air jet is a convenient adjunct to a fretsaw—whether hand or foot driven—for removing sawdust, and, again, a supply of compressed air can be of use for testing joints under water or otherwise, and, perhaps, on occasion, for running small steam engines for brief periods in cases, perhaps, in which the heat of steam may be objectionable. But, apart from all this, the compressor is a rather simple little machine of which to construct a scale model, and it lends itself to a great measure of dimensional variation and to variable disposition and number of its working cylinders and other parts.

Compressor Types

The type of compressor now in general commercial use is either of the *single* cylinder air-cooled type or of a much larger type having *two* cylinders cooled by a flow of jacket water. Both types have their cylinders disposed vertically, and both usually bring about air compression in a " single stage." (It may not be out of place to explain here that *two* or *three* stage compression, in the case of high pressures, is introduced for reasons similar to " compounding " in the steam engine—viz., to put up a barrier against heat-loss.) Small compressors are, of course, very largely used for motor-tyre filling, whilst the larger twin-cylinder machines provide, as one instance only, the motive force for those abominably noisy tools often to be seen and heard in our streets—and frequently referred to as pneumatic—or even electric "drills." (The reader will, of course, think of them as pneumatic *picks*.)

For the model illustrated on these pages, the simplest form of compressor has been selected, viz., a single cylinder air-cooled single-stage machine, and in order to carry this note of simplicity further, castings, and hence patterns, have been, so far as is possible, avoided. Moreover, certain parts which are either capable of considerable variation or which may be purchased *over the counter* have not been detailed very fully. For example, it is intended that the crankshaft and the flywheel shall be purchased machined and ready to put into place, whilst the base chamber, which may, perhaps, be largely left to the whim of the model maker, is merely suggested in a general way on the arrangement drawings—plus a few dimensions in the text.

Before making more minute reference to the details, it may be well to run briefly over the arrangement drawings shown in Figs. 1 and 2. Fig. 1 shows an elevation with the base chamber and flywheel in section, whilst Fig. 2 shows a transverse section through cylinder, piston and base chamber. In both views the piston is shown at mid-stroke position. Both valves—inlet and outlet—are contained in the head, and both are of quite normal conical-seated form. It is important that the clearance volume, when the piston is at the inner end of its stroke, shall be an *absolute minimum*, for it will be realised that any air compressed, and not discharged, will expand on the next out-stroke and hence hinder the introduction of a fresh change of air. For this reason, valve pockets are almost absent and the piston is intended to approach within about 1/32" of the inner surface of the head. Heat generated as a result of compression is to be dissipated by the fins on the cylinder wall, and the fairly considerable surface provided by the cylinder head. Air intake is by way of the slotted pipe with a small end plug—constituting to some extent an air-cleaner—on the right-hand side of Fig. 2, and discharge occurs by the short elbow-fitted pipe on the left-hand side of the same view.

Lubrication

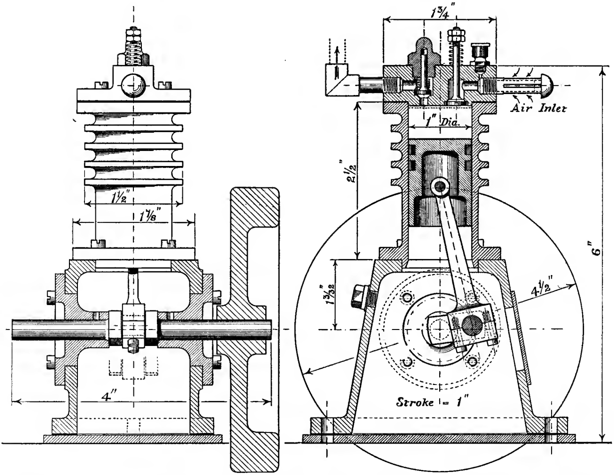
It is intended that cylinder lubrication shall be intermittent only, so that a cup lubricator is arranged to feed a little oil to the air-intake as required. This oil will be drawn into the cylinder by the air inflow and sprayed on to the cylinder walls. Splash lubrication can be applied to the base chamber—if the bottom plate joint is a sound one; otherwise oil will have to be fed to the big-end and main bearings by an oil-can. (In any case, I think oil fed to the cylinder top will very materially assist the pressure-tightness of the rings.)

The flywheel should be a heavy one, preferably of disc pattern, and, indeed, if driving conditions permit, it would be by no means disadvantageous to fit a flywheel to *both* ends of the crankshaft. Weight is desirable to damp out cyclic speed variation.

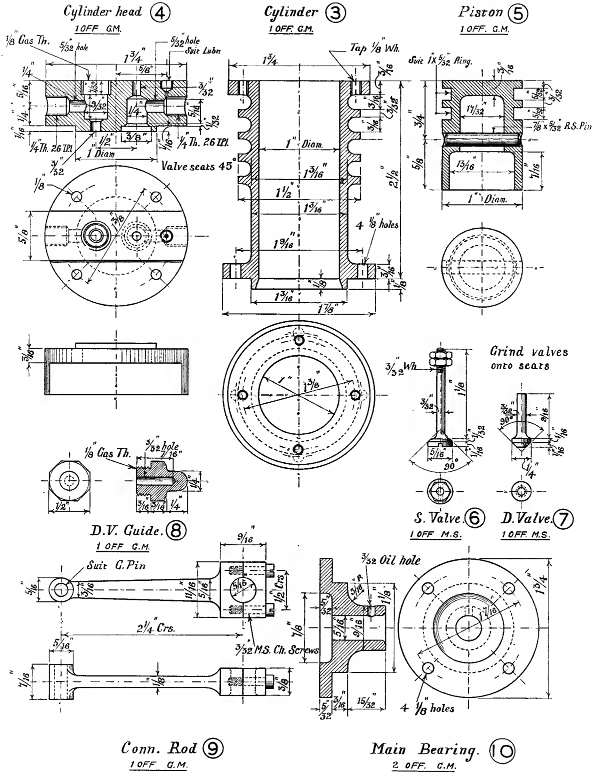
Now the details must receive some little attention. The cylinder shown in Fig. 3 is intended to be made from the bar (2″ diameter), this being probably the most straightforward method when a single machine only is to be made. The grooves shown can be conveniently cut with a suitable tool so as to leave quite effective radiating fins. Facing, boring and the drilling of a few holes will be about all the machining operations necessary for this part. Fig. 4 shows three views of the cylinder-head. This part again is intended to be made from 2″ bar, and there should certainly be no necessity for a pattern. It will be observed that in order to reduce weight, and, incidentally, add to cooling surface, two segments are cut away, the resulting shape being, perhaps, best indicated in Fig. 1, though the two lower views of Fig. 4 also show this feature. The 1″ diameter must, of course, register in the cylinder bore, though, indeed, exact registration is not very important. There are a fair number of drillings and tappings in connection with this part, but since both valves, with their accompanying ports, are here situated, this cannot well be avoided.

The piston is shown in Fig. 5. Two rings of stock size, viz., 1″ × 5/32″, are provided for. The usual care is called for in cutting the grooves so as to accurately fit the rings. It is intended that the gudgeon-pin should be made from a piece of silver-steel or stainless steel, and that the pin shall be a *press* fit in the piston-skirt and a good *working* fit in the small end of the connecting-rod. It will be observed that as the interior of the piston is bored it is not possible to provide the usual gudgeon-pin bosses, so that there is considerable end clearance hereabouts. End movement of the connecting-rod is limited by the crank webs. As the speed of the compressor is not very great, no particular effort has been made to reduce piston weight. (Indeed, need inertia stresses be considered at all in such diminutive working parts?)

Figs. 6 and 7 show the valves, the former the induction valve and the latter the delivery valve. These small parts call for no special comment, except to remark that the dimensions should be closely followed. The spindles should not, of course, be tight in their respective guides; indeed, the valves should, when dry, fall by the influence of their own weight only. Especially so, as the coiled springs to hold them on to their seatings should not give a load of more than 4 oz. or



Figs. 1 and 2. General arrangement and part sectional elevation of a 1-in. × 1-in. single-stage air compressor.



Figs. 3 to 10. Dimensioned and sectional details of the single-stage air compressor.

thereabouts. The inlet valve is slotted for grinding-in with a screwdriver; other means must be found for holding the delivery valve—perhaps a wood plug with an axial hole to fit the valve-spindle. Fig. 8 is the guide-plug for this valve.

A suggested connecting-rod is depicted in Fig. 9. This rod is intended to be cast in gunmetal, and as the pattern is a simple little one to make, perhaps this mode of manufacture will not be objected to. Note, by the way, that the big-end is intended to embrace the pin of a stock crankshaft (pin diam. 5/16″ × ⅜″ long), and do not forget that the hole in the small-end is to be a *working fit* on the gudgeon-pin.

A design for the main bearing is given in Fig. 10, and the dimensions given are only correct if the following crankshaft particulars are adhered to:—Diameter of crankshaft, 5/16″; distance outside crank webs, ¾″.

No detail drawing of the base chamber is thought to be necessary but the following are the main dimensions:—Height from top to bottom face, 2¾″; distance from top face to crankshaft centre, 1 3/32″; top facing (square), 2″ × 2″; width of open end at bottom, 2¾″.

The open end is closed, by the way, by a piece of brass or steel plate, 4¼″ × 2¾″, and about 10 s.w.g.—attachment being made by, say, half a dozen *countersunk* screws inserted from the underside.

Now, in regard to speed of operation—when the little machine is ready to run—this will depend upon a number of factors, such as the power available for driving, the working pressure to be maintained in the receiver, and the volume of air needed for any specific purpose. I think the compressor should be capable of a speed of 1,500 r.p.m. if the receiver pressure is a low one. At *considerable* pressures it may be difficult to get rid of the heat due to compression. The best form of receiver for use with a small compressor of this kind would be of cylindrical shape, composed of light sheet steel with a welded longitudinal seam and end-plates. The receiver should be fitted with a pressure gauge and safety-valve—so that blowing off may occur just as in a steam boiler. Perhaps if one were sufficiently interested, it would be no difficult matter to devise some simple form of pressure regulator connected with the inlet valve (holding down this valve will, of course, put a stop to any compression of inhaled air).

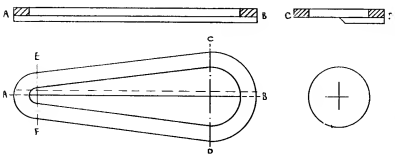
A final glance at the drawings has suggested a few points that call for reference. The materials for both cylinder and piston can be varied to suit available supplies, for example, mild steel, cast-iron and even brass are alternatives to gunmetal. Possibly some *stock* piston and connecting-rod may be made use of—but if *dimensions* are altered, *piston clearance* must be retained. The drawings give a clearance of 1/32″ (plus gasket thickness), and this should be about correct.

In regard to method of drive—direct-coupled, belt, or gear-drive are available, but the drive selected must, naturally, be influenced by the power and speed which can be called into use, as well as by the working pressure in the compressor and receiver system.

In fact, it would seem that a small scale single-stage air compressor, such as has been described and illustrated, quite apart from the possible uses already referred to, may provide a number of interesting little "side-shows" and studies of an experimental nature.

A CENTRE GAUGE

IF you wish to find the centre of round bar quickly and easily, make yourself a gauge, as illustrated. I suggest you make it of brass, as it will not rust. Bolt the two parts together. The example is for bar ¼″-1″. Mark a centre line, *A-B*, centre-pop at one end and scribe a circle, ⅜″ radius, from edge of circle on centre-line, mark off 3¾″, centre-pop and scribe ¾″ radius circle. Join the two circles at *E-C* and *F-D*, then saw and file to shape. Drill ⅛″ holes in centre of circles at centre-pops, open to ¼″ and 1″ at other end, scribe lines as before, joining two holes and then saw out the centre piece; draw-file to finish.



Clamp a piece of brass with a straight edge up to the centre-line, *A-B*, drill for countersunk bolts. When they are bolted together, file until shaped. Bevel straight-edge if you desire.—C. H. ISAACS.

A Kentish "Mary Ann"

By "L.B.S.C."

WHEN reading my correspondence, which, incidentally, is rapidly returning to normal—though some of it is coming from unfamiliar addresses!—I have often pondered over the peculiarities and extremes of human nature. For example, somebody will write and say he is just going to make a start on one of my engines, but before doing so, wants to know about various aspects of the job, and whether his equipment is adequate, and so on and so forth. Then along comes a letter from some quiet unassuming personage, to say he has tackled an engine and carried it through to a successful conclusion, maybe encountering a hitch or setback here and there, but patiently plodding the road to success, unaided and undefeated. There are various "intermediates," naturally; but I want to say right here that I am *always* pleased to hear from anybody, any time, and nobody ever need feel shy or diffident in writing, as some correspondents apparently are.

One of the latest in the "do-it-first" category is a North Kent friend, Mr. Albert Cross, who sends the reproduced photographs of the result of five years' spare time work, carried out at intermittent intervals as opportunity permitted. The Kentish "Mary Ann" was built to the instructions given in my original "Live Steam" notes, the only variations being details altered to utilise existing material, or necessitated by available facilities. A case in point was the eccentric-driven feed pump, which was machined from the solid instead of being built up.

Mr. Cross started operations without any lathe or drilling machine, and for eighteen months carried on with the various parts of the locomotive which could be made without the assistance of those useful machine tools; but eventually he arrived at the point where it was a case of getting a lathe or quitting the job, so he obtained a 4" "Pool Special" and an electric motor to drive it. Locomotive work was suspended whilst the lathe, countershaft and motor were installed and connected up in a workshop at the bottom of the garden; and a Kennion drilling machine was also added. Various other jobs then came along, as usual, to purloin time which would otherwise have been spent on the locomotive; but eventually she was finished, and Mr. Cross hopes to enter her in the next MODEL ENGINEER Exhibition. Our friend says that although the engine is a first attempt, locomotives "run in the family," in a manner of speaking, as his father and grandfather were "full-size" locomotive men, on the old North British and the London and South-Western. A typical case of "what's bred in the bone," as the old saw has it.

The Kentish "Mary Ann" has no track at present, work on a 55' straight run having been temporarily suspended, owing to the activities of Mr. Hitler making A.R.P. work take precedence; but it is hoped to complete the line during the coming winter, as the woodwork is already up. A four-wheel car, made to my notes, is all ready for test, and it is hoped later to build a bogie passenger car. Mr. Cross says he has no experience of firing

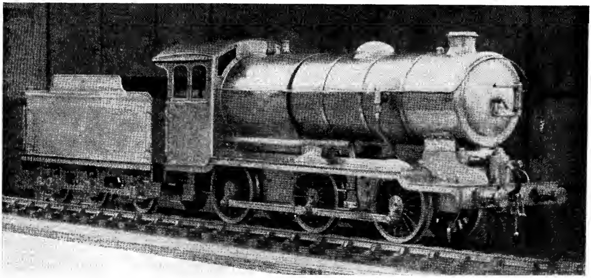


Photo by] **A "Mary Ann" of Kent.** [*W. H. Banyard*

a little boiler, but he need have no fear. If the instructions on driving and firing, which have been given several times in past instalments of my notes, are carefully followed, the locomotive will behave in a way that will probably be far beyond her builder's expectations. Hearty congratulations to our " brother of Kent " on a very nice piece of work.

MISS TEN-TO-EIGHT

Smokebox

Most of the engines described in these notes have had a circular smokebox mounted on a cast or built-up saddle. This one is a little different, having no separate saddle in the ordinary sense of the term, the sides being carried completely around the barrel of the smokebox, and forming a kind of supplementary wrapper. It is, of course, quite possible to make this wrapper actually serve as the smokebox proper, by fitting a flat bottom to it, and a ring for attaching to the boiler; but whilst you are doing all that, and getting the joints tight, the present construction can be erected and finished, without fear of air leakage or other little worries and troubles.

The barrel is a piece of 16 gauge brass tube, $4\frac{5}{8}''$ diameter and 3 9/16" long. Both ends are squared off truly in the lathe. If your three-jaw will not open wide enough to grip the tube in the usual way, with a disc of metal of something similar jammed in to prevent distortion, put it over the highest step of the outside jaws and slide it right back as far as you can without fouling the chuck key. A moderate grip from the inside will then hold it quite firm enough for facing the ends. Note the rear end is bevelled off; this is to simulate the brass ring covering the angle joint on the full-size engine.

The wrapper sheet can either be made from 16 gauge brass or steel sheet, bent around the barrel and secured to the bottom part just where it bends down to meet the frames, or made from a piece of the same tube, $3\frac{1}{2}''$ long. This can be sawn longitudinally at the bottom and opened out similar to a firebox wrapper; it can then be sprung on to the barrel, and by virtue of its original shape and size will lie snugly against the barrel, and " stay put " without any fixing. Take a good look at the sketch, and note how the wrapper is fitted on the barrel; the squared end (front) of the barrel is 3/32" inside the wrapper, to allow for a flush front plate, whilst the back (bevelled off) projects 5/32" beyond the wrapper, for the purpose just stated.

The front ring, in this case, actually is a ring

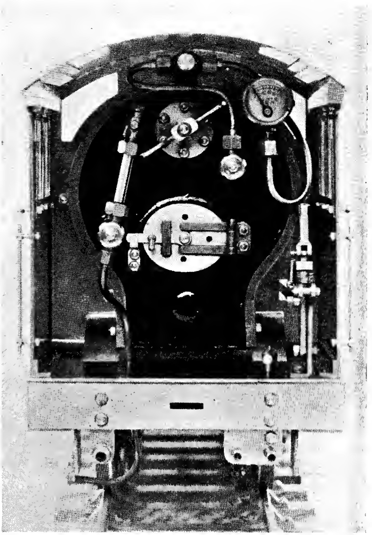


Photo by | **Cab view of the Kentish " Mary Ann."** [*W. H. Banyard*

instead of a flanged disc. Soften a 14" length of $\frac{1}{4}''$ square brass rod, bend into a ring a little over $4\frac{1}{2}''$ diameter, and silver-solder the ends. Chuck in the three-jaw, same as you did for the barrel, face one side, and turn down the outside to a diameter that will just push tightly into the barrel. This forms the attachment for the front plate, which is cut out of a piece of hard-rolled sheet brass, or something equally true and flat. Leave it a shade on the large side. Cut a 3" hole in it, and rivet the ring to it, as shown in the sketch, the turned face of the ring making contact with the front plate. Now trim off the edges of the plate, so that when the whole lot is put in place at the smokebox front end, the ring will enter the barrel, whilst the front plate will lie snugly in the rebate between the barrel and the wrapper, see sketch.

The door may be a casting or built up. Probably some of our advertisers may be able to supply a $3\frac{1}{2}''$ door casting from stock, as it is a

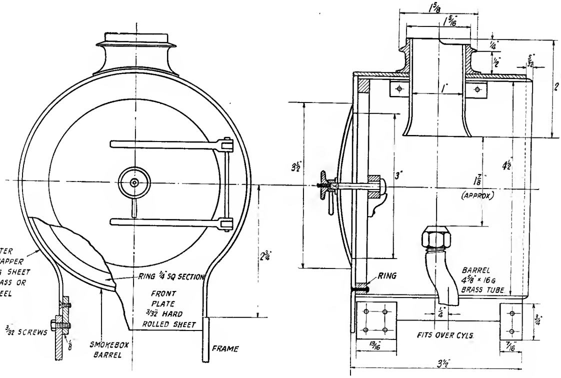
common size; but a door is no trouble to build up, a stamped brass blank, $3\frac{1}{2}''$ diameter and $\frac{1}{8}''$ thickness (commercial article costing but a few pence), being the easiest thing to make it from. Alternatively, it could be cut from $\frac{1}{8}''$ sheet with a metal fretsaw. Anneal the blank, place it on a block of lead, and assault it with the ball end of the hammer until it looks like a saucer. Chuck in three-jaw, concave side out, centre, drill No. **30**, and face off a little circle about $\frac{3}{4}''$ diameter in the centre. Turn a pip on the end of a piece of $\frac{5}{8}''$ or $\frac{1}{2}''$ brass rod, to jam tightly in the No. **30** hole, the faced portion of rod around the pip, bedding down on the faced circle of metal. Solder the rod to the dished blank, chuck the rod in the three-jaw, and you can then turn up the outside of the door and face the contact rim, at the one setting. Melt off the brass mandrel, and there is your door. The hinges are filed up from $\frac{1}{8}''$ by $\frac{1}{4}''$ German silver rod, and riveted on with domestic pins. Mention of those always bring me a smile. Somebody once telephoned me to ask where he could buy " dome-stick " pins; not in jest, but quite serious!

Front Plate

The front plate must be perfectly true, or else the door will not close airtight; so test it by rubbing on a sheet of emerycloth laid on something true and flat, such as the lathe saddle, or a drilling machine table. Then put the door in place, and mark the position of the hinge lugs. These are turned up from $\frac{1}{8}''$ by $\frac{1}{4}''$ German silver rod held in the four-jaw, the stems or shanks being **3/32"**. Leave the lugs fairly large and undrilled. Screw them into the front plate, and put the door back again. A No. **51** drill can then be run through lugs and hinge bosses, a **1/16"** headed pin put in, and the lugs rounded off with a file, to come flush with the hinge bosses.

Crossbar

The crossbar is simply two $4\frac{1}{4}''$ lengths of $\frac{1}{8}''$ by $\frac{1}{4}''$ mild steel, riveted together with a distance-piece, **5/32"** in thickness, near each end. It is supported on two small brackets, see sketch, riveted to the ring, one at either side of the door opening. The dart and handles are the same as for the $2\frac{1}{2}''$ gauge engines, the dart being made from a $1\frac{3}{8}''$ length of $\frac{1}{4}''$ round steel, with a tee head brazed on one end. The other end is turned down for $\frac{1}{4}''$ length to **3/32"** diameter, and threaded; a further $\frac{1}{8}''$ is squared. A steel boss, $\frac{1}{8}''$ thick and $\frac{1}{4}''$ diameter, is drilled **3/32"**, and the hole squared with a watchmaker's file, to fit the square on the dart; the boss is furnished with a steel handle, screwed or silver-soldered in. A little wheel is turned from $\frac{5}{8}''$ round rod, and tapped to fit the screw. The assembly is shown in the sketch.



Smokebox for Miss Ten-to-Eight.

A hole, $1\frac{1}{8}''$ diameter, is made in the top of the smokebox, right through wrapper and barrel. A 2″ length of brass or copper tube is softened, and the bottom belled out a little as shown. Cut a piece of sheet copper 2″ square, anneal and bend to same radius as inside of smokebox barrel. Make a hole in it to fit the liner tube, and silver-solder it in. By the way, will new readers please note that *fully detailed* instructions, simple enough for the rawest tyro to follow, have been given several times during the past couple of years or so, on all these odd jobs such as turning up parts, cutting holes in sheet metal, silver-soldering, etc., and too-frequent repetition will bring the Knight of the Blue Pencil on my track mighty quick! Smear a little plumber's jointing around the liner on the convex side of the flange, and poke the straight end through the hole in the top of smokebox, from the inside. Fix the whole issue by four 8 B.A. countersunk screws, nutted inside the smokebox. The outside chimney, which is of the type fitted to the North-Eastern "Raven" "Pacifics," before amalgamation in the L.N.E.R., is turned up from a casting, which can be supplied by our advertisers, and is just a tight push fit over the liner. It does not need any screws or other fixings.

The cross centre line of the cylinders does not come exactly underneath the chimney, but $\frac{1}{4}''$ behind it, so the 7/16″ hole for the blastpipe must be drilled that much to the rear. The position of the hole for the steam pipe can be measured off from the blastpipe connection on the steam-chest cover, and transferred to the bottom of the smokebox, the hole then being drilled for the pipe. Tip: do not forget that the measurements are "reversed" when transferring, or you will find the hole is on the wrong side of the smokebox when drilled!

When in position on the frames, the lower edges of the wrapper rest on them, the cylinders coming between; and to keep the wrapper in position, four connecting-pieces are used. These are made from $\frac{1}{8}''$ brass sheet. Two are 13/16″ long, and two 7/16″. all $\frac{3}{4}''$ wide. The longitudinal sketch of smokebox shows where they are fixed, and the front view shows how; they are attached to the lower edge of the wrapper by 3/32″ countersunk screws, so that when the boiler is mounted, the lower halves go down between the frames, at each end of the cylinder block, and are attached to frames by hexagon-headed screws put through some of the little holes drilled along the top edge of the frames. The vacant holes, by the way, can either have dummy screw heads, on spigots, squeezed into them, or you can drill and tap shallow holes in the steam chest walls, and put in short hexagon-headed screws to match the others, for appearance sake.

The space at the back of the smokebox, between the wrapper sides and the bottom of the barrel, is filled in with a "make-up" piece, like a throatplate, of 16 gauge brass, either attached by a little piece of angle in each corner, or silver-soldered to the $\frac{1}{8}''$ plates by which the smokebox is attached to the frames. There will be no need to provide screws, or any other "positive" fixing, between the smokebox and boiler, as the former merely slides on to the latter a tight fit, with a smear of plumber's jointing to prevent any air leaking in. Do not, however, attach it yet "for keeps," as we have to fit the superheater and blower ring before this can be done. Well, it looks as though I have used up all my space this week, so will have to defer illustrations of "mass-production" screw-making tools until the next instalment of these notes.

Luminous Paint

WE have received several enquiries for a formula for making luminous paint, and, therefore, reprint below a recipe that is given, with others, in Spon's "Workshop Receipts."

In making luminous paints, a vehicle that is used with advantage is a varnish that has no trace of lead in its composition, for lead has a prejudicial effect on the luminous ingredient. This varnish is made of Kauri or Zanzibar copal, 6 parts, oil of turpentine, 24 parts, the copal being made into a molten state and then dissolved in the turpentine. When this solution is made, it is filtered and mixed with 10 parts pure linseed oil (without lead in it), the oil being well heated and allowed to cool before the copal solution is mixed with it. This completes the varnish.

In dealing with dry materials, these should be ground before mixing. A paint-mill is suitable for this, but the rolls or grinding surface should not be iron, if possible, as minute particles of iron are carried in the ingredients with bad effect. The chief dry ingredient is luminous calcium sulphide. This is made by mixing 50 parts of lime with 20 parts of flowers of sulphur and heating together in a closed crucible until fumes cease to be evolved. The substance remaining is calcium sulphide, and requires to be powdered finely.

The paint is then made by mixing together 10 parts of the varnish, 1.5 parts of calcium carbonate, 3 parts of white zinc sulphide, 1.5 parts of barium sulphide, and 9 parts of luminous calcium sulphide.